



HINS R&D

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Integration, testing and commissioning

Bob Webber

Fermilab Accelerator Advisory Committee

May 6, 2008



## HINS - AAC History

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- First HINS presentation to AAC was two years ago, May 2006
- Most recent HINS presentation to AAC was August 2007





## Talk Outline

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- Preview of today's message
- Reminder of HINS Program R&D Objectives
- 2008 Goals in Meson Lab
- Current status
- Facility Layout
- Cavity test cave cryogenics
- Plans for beam operations and preparations for RFQ commissioning
- Technical systems updates
- BNL collaboration
- Resource tight spots
- Summary





## Today's Message

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- Progress is being made in many areas of the HINS program
  - Two room-temp spoke cavities have been successfully commissioned to full peak RF power; two more await
  - New modulator charging supply is installed and commissioned
  - Proton ion source system is substantially complete for initial beam operations
  - Final preparations are underway for RFQ installation and initial power testing
  - Cryogenics distribution equipment for cavity test cave is being procured
  - SC solenoid magnet power supply & quench protection system design has begun
- ... but more slowly than anticipated
  - RFQ completion and delivery has been delayed considerably
  - Ion source is still in MS6
  - Cryo distribution and test cryostat facility to allow full pulsed power testing of SSR1 will not be ready before late 2008





# HINS Program Objectives

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- Demonstrate high power RF distribution and 3.5 msec pulse operation of multiple cavities powered from a single klystron
- Demonstrate performance of 325 MHz high power vector modulators for amplitude and phase control of multiple cavities
- Measure axially-symmetric beam performance with room-temperature crossbar spoke resonator cavities and SC solenoid focusing in the front-end Linac
- Demonstrate high intensity beam acceleration at 10 MeV and beyond using superconducting spoke resonator RF structures
- Demonstrate high-speed (nsec) beam chopping at 2.5 MeV
- Demonstrate performance of this Linac design concept and measure the resulting beam quality to 60 MeV

This all adds up to building a one-of-a-kind superconducting  
60 MeV H- linac



## HINS 2008 Meson Goals

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- Relocate proton ion source from MS6 to MDB and re-commission - May/June
- Receive RFQ from ACCSYS - June/July
- Commission RFQ to full RF power - July/August
- Receive and RF condition the remainder of room temp cavities - August thru December
- Establish 2.5 MeV beam from RFQ - November
- Install test cryostat and cryo transfer lines for HINS test cave - December
- Test first SSR1 SC spoke cavity to full pulsed power - December?
- Design and begin construction of linac shielding cave in MDB - December



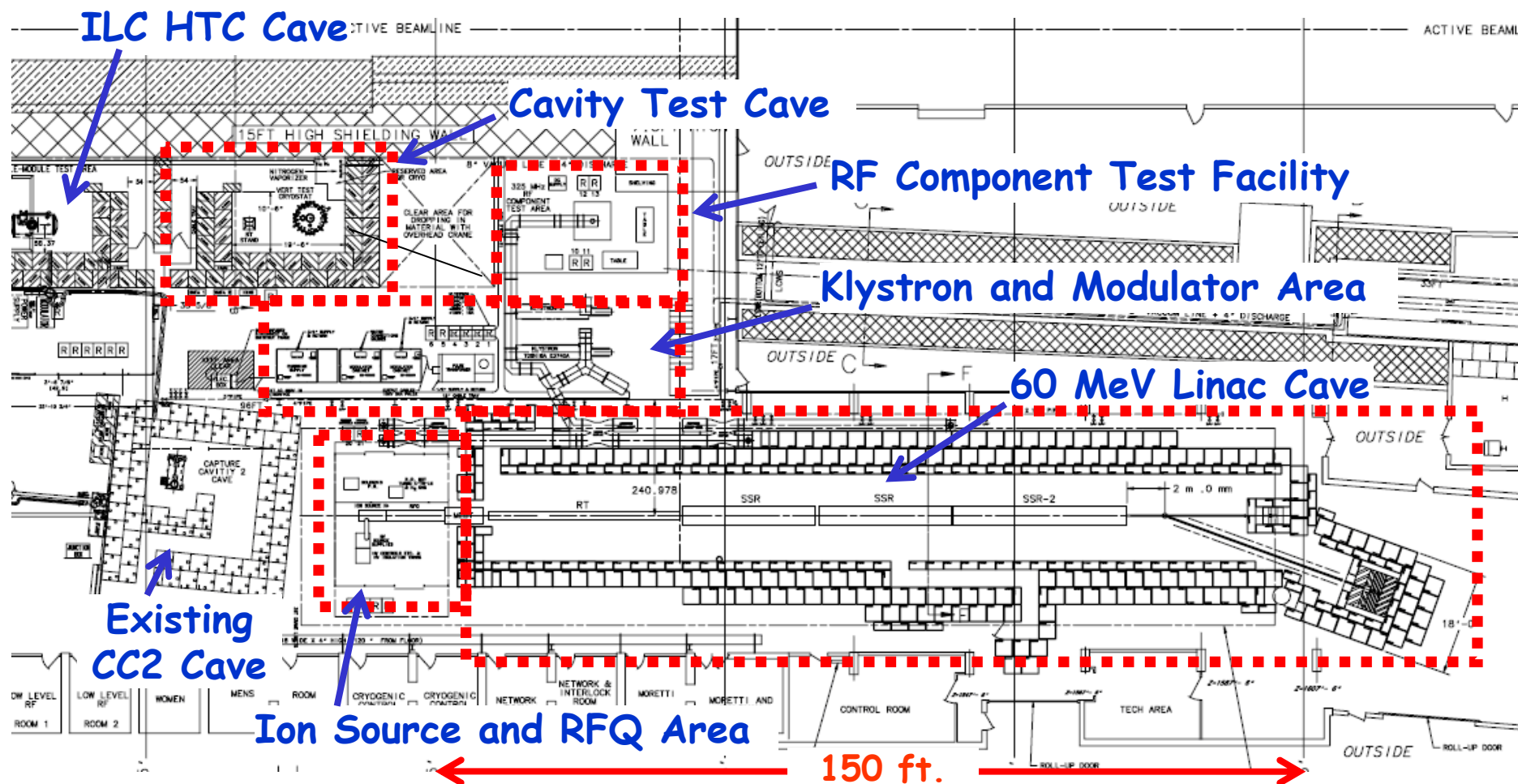
## HINS Status

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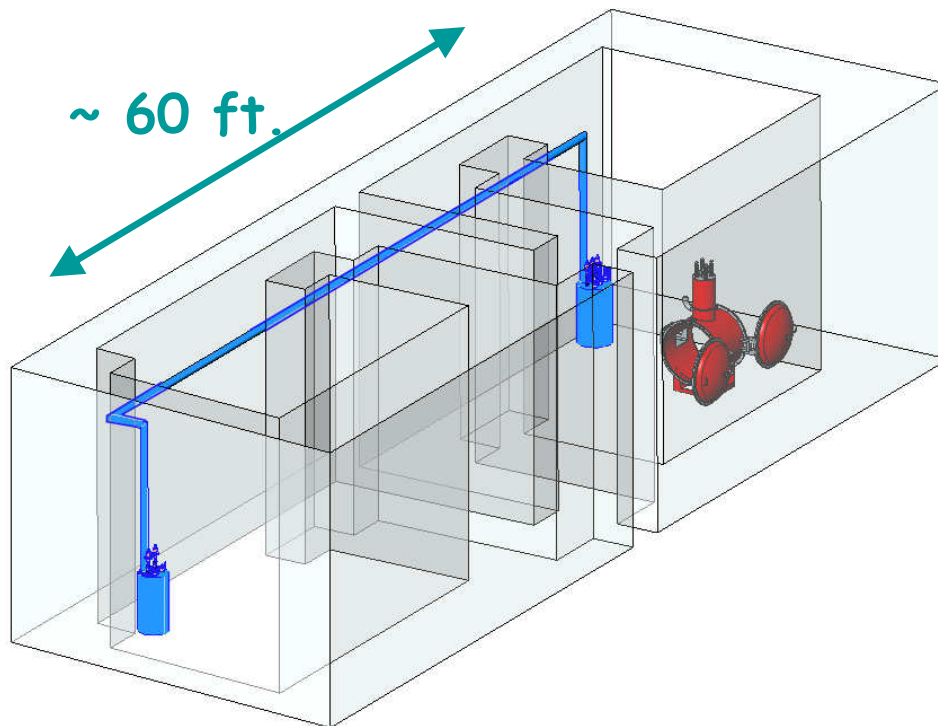
- 2.5 MW, 325 MHz HINS klystron is operational
- HINS RF Component Test Facility is operational
- RF high power vector modulator testing is in progress
- Room temperature cavity conditioning is in progress
- Ion Source/RFQ Area is outfitted with utilities
- RFQ infrastructure system details are being finalized
- Proton ion source/LEBT system is operational in MS6
- H- ion source development is underway
- Design of power supply and quench protection systems for superconducting solenoid magnets has begun
- Vector modulator bias power supply system design is ongoing
- LLRF system from SNS for 2.5 MeV beam operations is installed and being tested in a low power system
- Cryogenics distribution equipment for cavity test cave is specified and in procurement



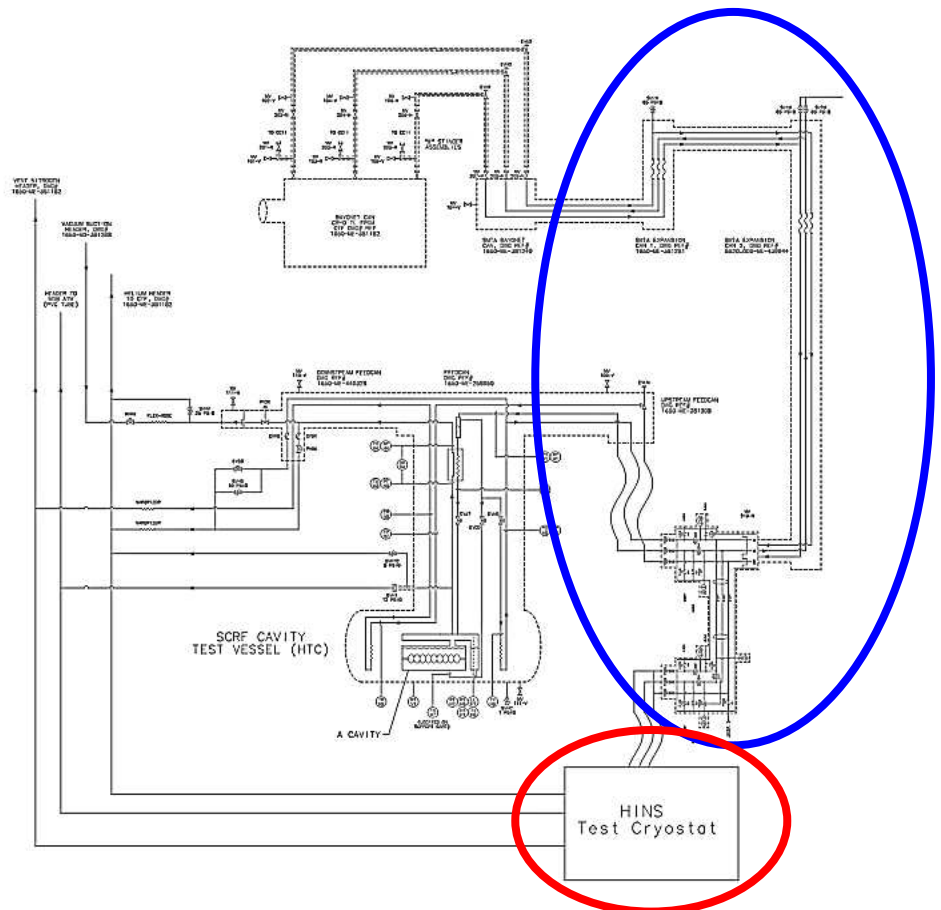
# HINS Floor Plan in Meson Detector Building



# Cryogenic Distribution System to Cavity Test Cave



- New cryogenics distribution components shown in blue
- HINS cavity test cryostat shown in red



- ILC HTS and HINS Test Cave cryogenics system diagram



# Cryogenic Distribution System to Cavity Test Cave



**Technical Specification**  
for  
**HINS Test Cryostat**  
**Cryogenic Distribution System**

1650 – ES – 381345

Revision 0

Author(s):	_____ Arkadiy L. Klebaner _____	Date: 2/27/08
Reviewed by:	_____ Jay C. Theilacker _____	Date: 2/27/08
Cryostat Interface:	_____ Thomas H. Nicol _____	Date: 2/27/08

- Specification for cryogenics distribution system and components was completed in February
- Bidding for design and fabrication closes May 16
- Anticipate ~6 months until delivery





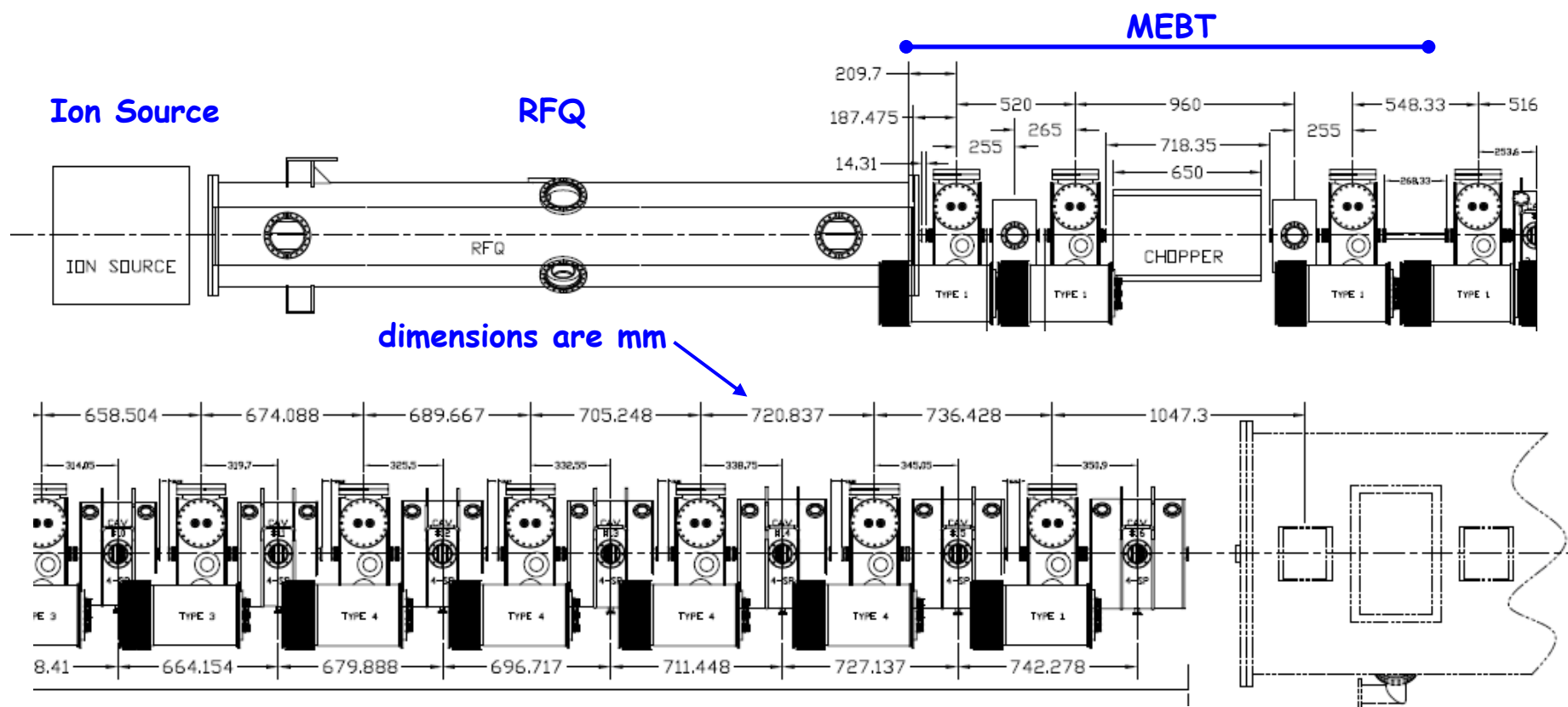
# HINS Beam Staging Thoughts

- **2.5 MeV operation**
  - With short diagnostic/transport line and absorber downstream of RFQ
  - Diagnostic line design is done and absorber is assembled
  - RFQ delivery and RF conditioning is still critical path
  - Goal: 2.5 MeV beam in the fall of this year
- **>2.5 MeV and <10 MeV operation ??**
  - Possible beam operation w/ MEFT plus first 4? RT cavities and solenoids
  - Beam test of RF distribution and RF high power vector modulator control
  - Not before early 2009
    - limited by enclosure construction, MEFT buncher cavities, LLRF development, and focusing solenoid production
- **Full 10 MeV Room Temperature section operation**
  - Fall 2009?
    - Solenoid production, magnet power supply systems, and cryogenics system are critical path
- **20 MeV operation with first SSR1 cryomodule**
  - Fall 2010? SSR1 cavities, cryomodule, and solenoids are needed
- **Full 60 MeV operation**
  - Late 2011?





# HINS RT Section Layout



Final 7 of 16 cavities/solenoids in Room Temperature Linac Section

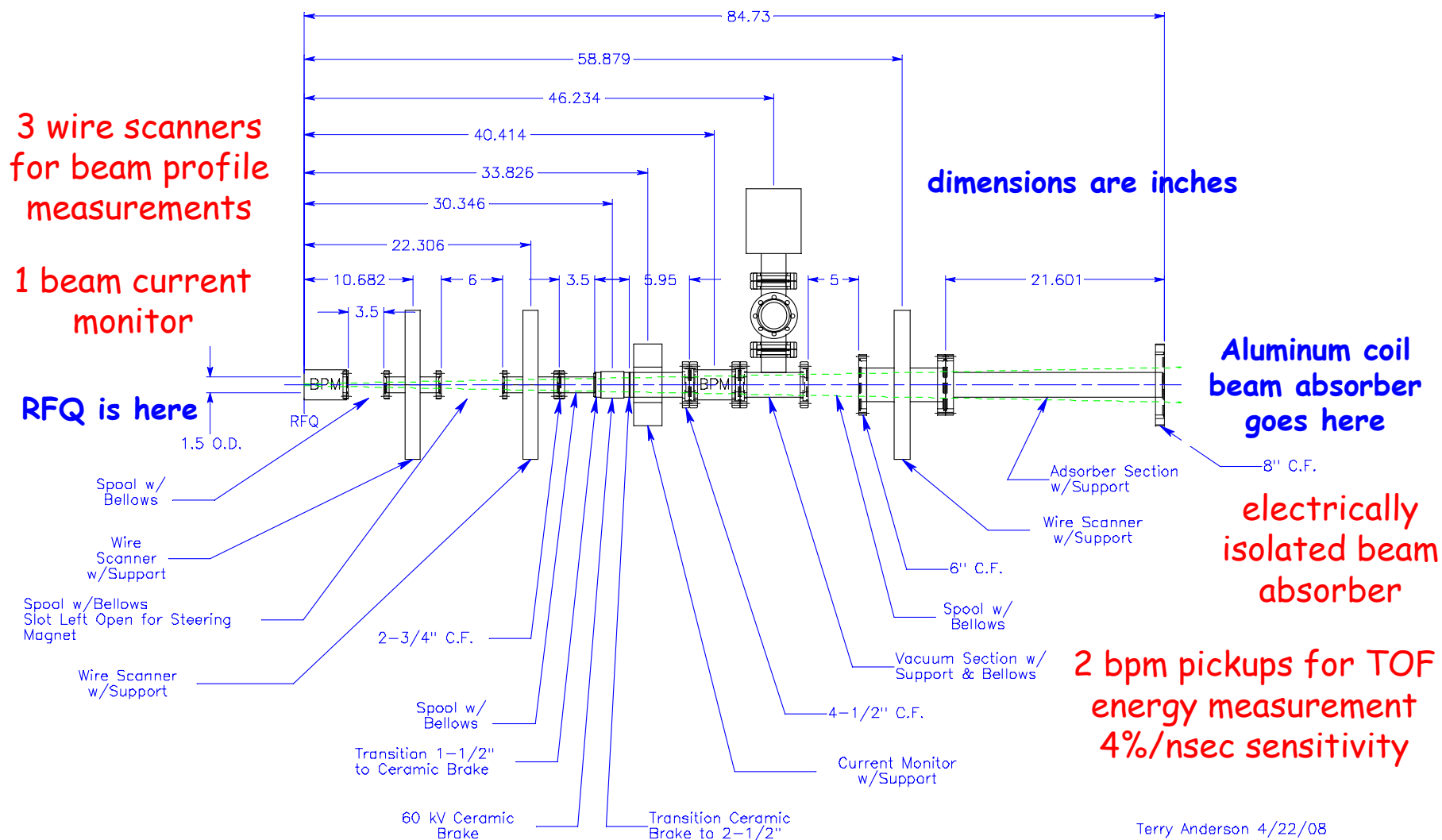
SSR BETA 0.22  
CRYMODULE  
(continued below)

Start of first  
SSR1 Cryostat





# 2.5 MeV Transport Line Plan



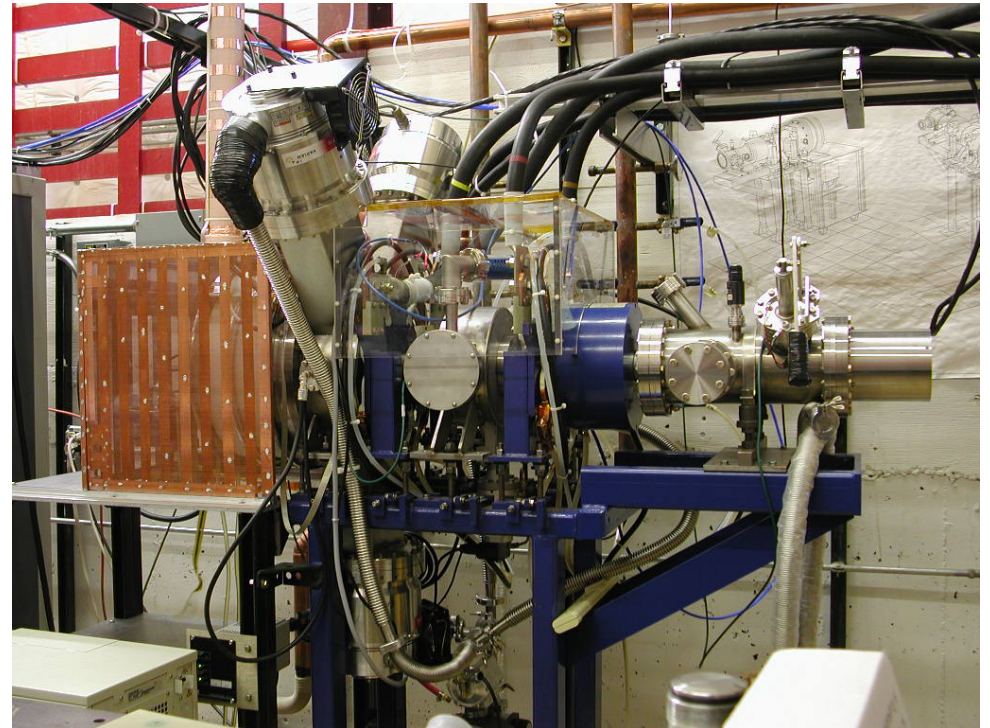
Terry Anderson 4/22/08



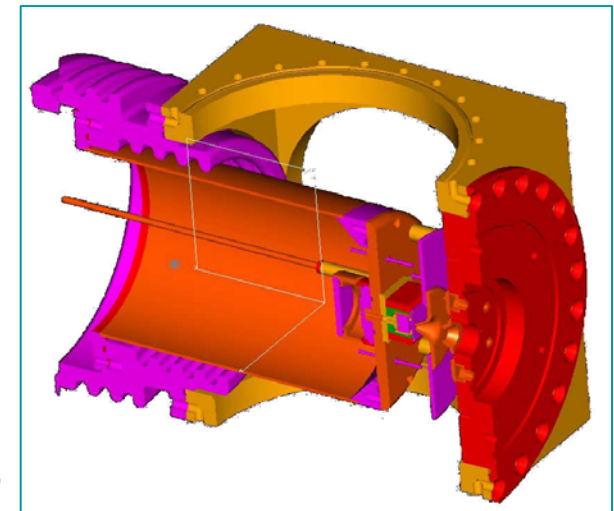
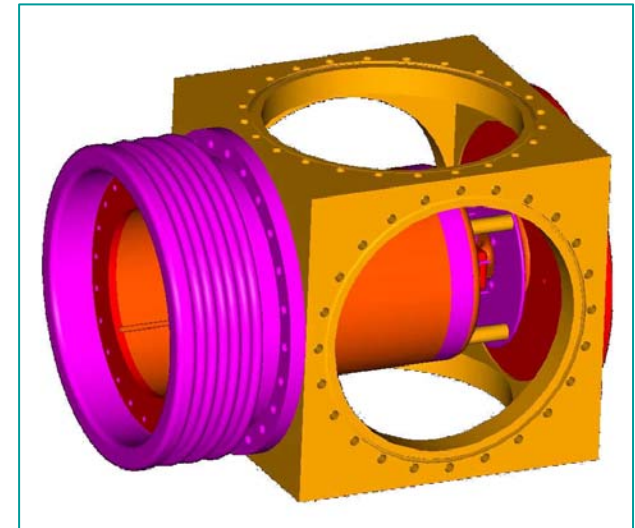
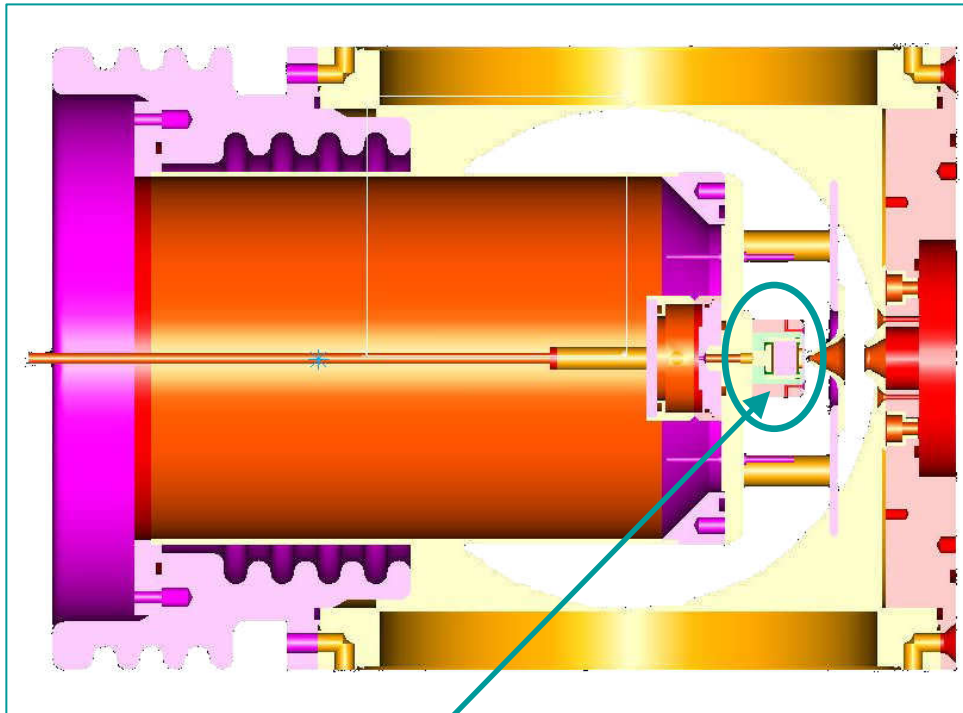
# HINS Proton Ion Source and Injector



Ion Source Control and  
High Voltage Racks



Ion Source and LEBT

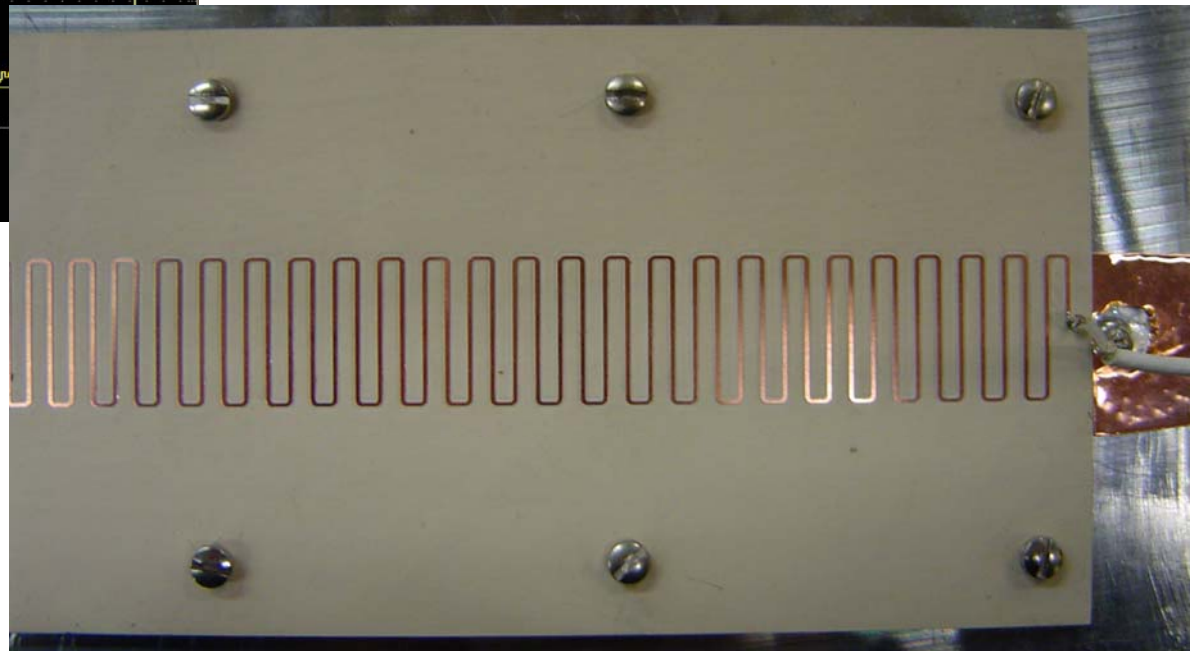


- Fermilab H- source re-configured to serve initial HINS H- operation
- This source is not expected to deliver full PD/HINS/PX duty factor capability
- Further source development is in PX R&D Plan



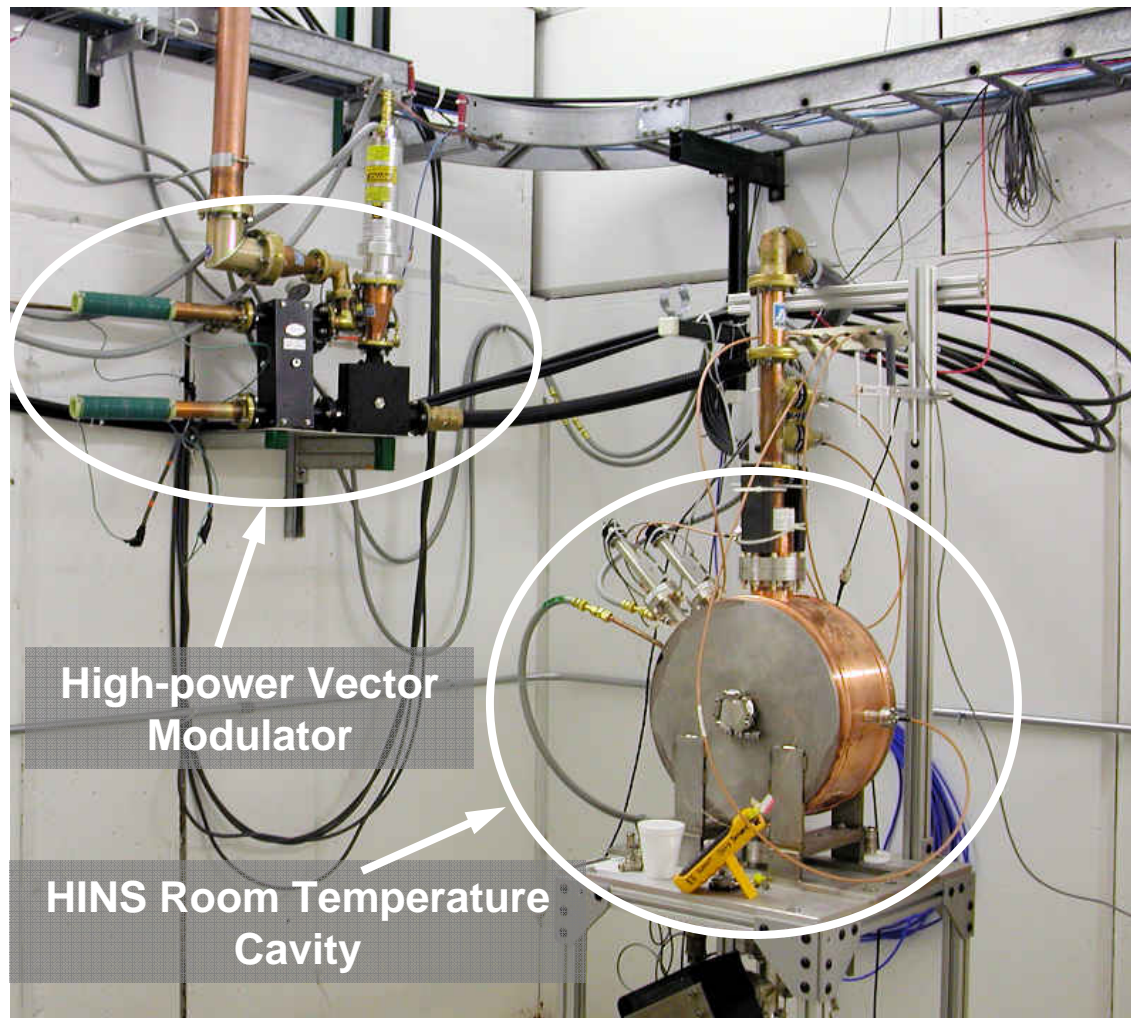
- 100 ohm meander slow-wave line
- 20 mm in transverse dimension

- 1.4 kV pulses from prototype KenTech pulser
- 5 nsec/div
- 50 MHz rep rate



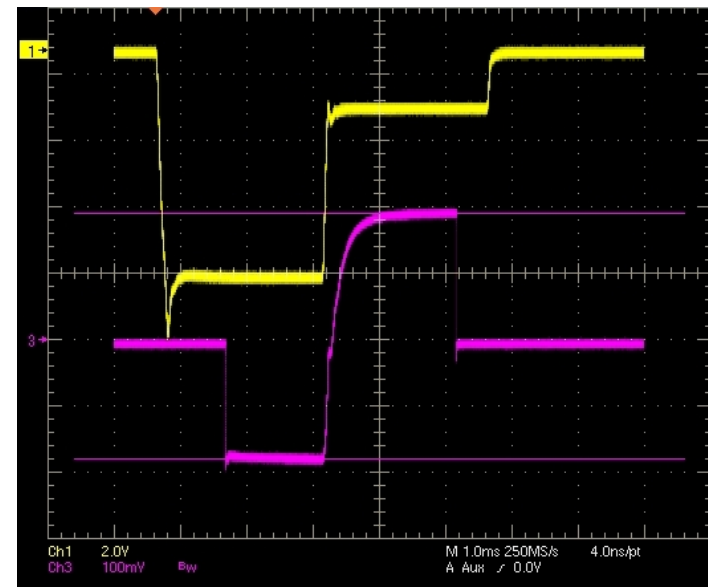
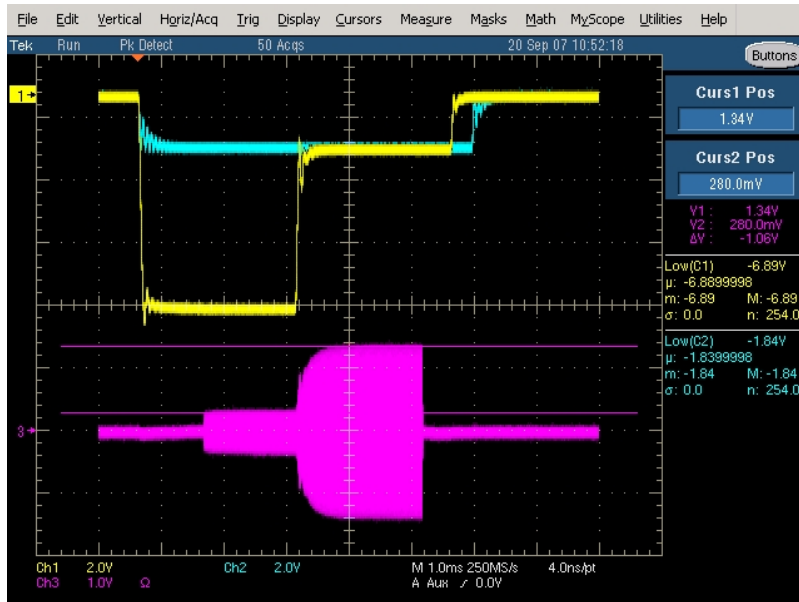


## HINS RT Cavity and Vector Modulator Operating in Cavity Test Cave





# Vector Modulator Performance with Cavity







## Laser Profile Monitor Collaboration with Brookhaven Lab

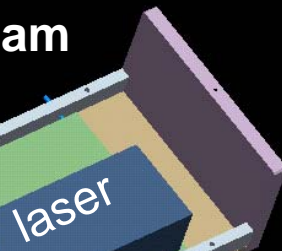
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- Collaboration with BNL is working to build a LPM to measure H- beam X and Y profiles for HINS
  - BNL is to deliver operational laser, optics box, electron detectors, and control system
  - FNAL will provide vacuum chamber, laser launch box and optical path for FNAL installation(s)
- Until H- is available in HINS, the first FNAL installation might be in the 400 MeV line to provide beam profiles parasitically during normal operation





## H- beam



## Linac Chute



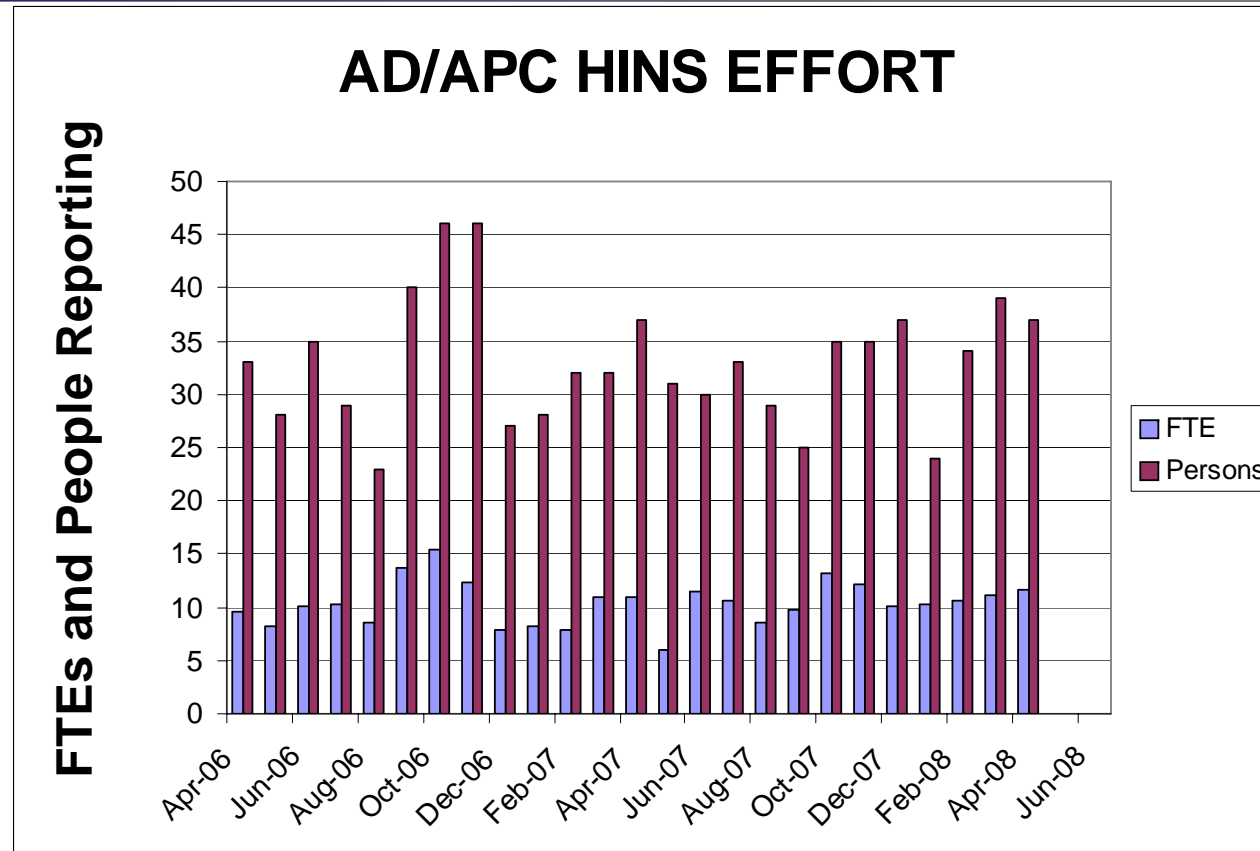


# Manpower Resource Tight Spots

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- Critical resource areas for HINS accelerator systems and integration, also in demand by other Laboratory programs, include:
  - RF power distribution system engineering and design
  - Low level RF systems - system design, modeling, hardware
  - Cryogenics system engineering and support
  - Magnet and vector modulator power and quench protection systems engineering
- Candid observation: HINS schedules presented to this committee previously have been overly optimistic
  - Furloughs, vacations, layoffs, etc will affect progress in coming months
  - Effort required for imminent Project X R&D program will further complicate the picture





- Typically ~35 AD/APC people integrate ~11 man-months effort each month
- Typically 7-9 people report HINS effort at >50% in any month

- The HINS R&D program remains very active
  - Goals remain the same
  - Ambitions remain high
- Progress has been made in:
  - Completion of the 325 MHz RF power system
  - High power vector modulator testing
  - Room temperature spoke cavity RF commissioning
  - Ion source systems
  - Preparations for RFQ installation and commissioning
  - Specification and procurement of cryogenic infrastructure for cavity test cave
- Current activity is concentrated on preparing for RFQ commissioning
- Certain key resources are in high demand and short supply
- Furloughs, vacations, layoffs, etc will affect progress in coming months
- Thus, uncertainty continues to accompany HINS schedules



## Back-up Slides

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